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# USAF BIOENVIRONMENTAL NOISE DATA HANDBOOK.

## Volume 102.

## A-10A In-Flight Crew Noise.



Technical rept.,

Harold K. Hille

OCTOBER 1976 15 p.

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AEROSPACE MEDICAL RESEARCH LABORATORY
AEROSPACE MEDICAL DIVISION
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FOR THE COMMANDER

HENNING E. VON GIERKE
Director
Biodynamics and Bionics Division
Aerospace Medical Research Laboratory

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The A-10A is a USAF single-seat close support aircraft. This report provides measured data defining the bioacoustic environments at the pilot's location inside this aircraft during normal flight operations. Data are reported for one location in a wide variety of physical and psychoacoustic measures: overall and band sound pressure levels, C-weighted and A-weighted sound levels, preferred speech interference level, perceived noise level, and limiting times for total daily exposure of personnel with and without standard

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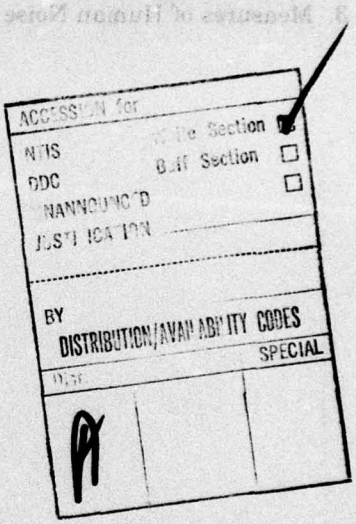
Air Force ear protectors. Refer to Volume 1 of this handbook, "USAF Bio-environmental Noise Data Handbook, Vol. 1: Organization, Content and Application," AMRL-TR-75-50(1) 1975, for diacussion of the objective and design of the handbook, the types of data presented, measurement procedures, instrumentation, data processing, definitions of quantities, symbols, equations, applications, limitations, etc.

# PREFACE

**This report was prepared by the Biodynamic Environment Branch, Aerospace Medical Research Laboratory, under Project/Task 72310418, Measurement of Noise and Vibration Environments of Air Force Operations.**

**The author acknowledges the efforts of John N. Cole who established the data analysis requirements and assisted in the preparation of this report, and Henry Mohlman and David Eilerman of the University of Dayton who assisted in the mechanics of data processing.**



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# INTRODUCTION

The A-10A is a single seat close support aircraft manufactured by the Fairchild Republic Company. Power is provided by two GE TF34-GE-100 turbofan engines each rated at 9065 lb maximum takeoff thrust. The engines are manufactured by the General Electric Company, Aircraft Engine Group, Military Engine Division.

This volume provides measured data defining bioacoustic environments produced inside the aircraft. Such data are essential to evaluate ear protection requirements, limiting personnel exposure times, voice communication capabilities, and annoyance problems associated with operations of the A-10A aircraft.

This volume is one of a series published by the Aerospace Medical Research Laboratory (AMRL) under the same report number (AMRL-TR-75-50) as a multi-volume handbook that quantifies the noise environments produced at flight/ground crew locations and in surrounding communities by operations of Air Force aircraft and ground support equipment. The far-field, community-type noise data in the handbook describe the noise produced during *ground operations* of aircraft, ground support equipment, and other ground-based equipment or facilities.

Volume 1 of this handbook discusses the objectives and design of the handbook, types of data presented, measurement procedures, instrumentation, data processing, definitions of quantities, symbols, equations, applications, limitations, etc. *Refer to Volume 1* (reference 1) for such information because it is not repeated in other handbook volumes.

A cumulative index lists those aerospace systems contained in the handbook, and identifies the specific volumes containing each type of environmental noise data available (i.e., inflight/flight crew and passenger noise, near-field/ground crew noise, far-field/community noise). Volume numbers are assigned sequentially as individual volumes are published. This index is periodically updated as individual volumes are published, and are available upon request from AMRL/BBE, Wright-Paterson AFB, OH 45433. Organizations on the distribution list for the handbook will automatically receive a copy of each updated index.

Direct any questions concerning the technical data in this report and other handbook volumes to: AMRL/BBE, Wright-Patterson AFB, OH 45433; AUTOVON 78-53675 or 78-53664; Commercial (513) 255-3675 or (513) 255-3664.

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1. Cole, John N., *USAF Bioenvironmental Noise Data Handbook, Volume 1: Organization, Content and Application*, AMRL-TR-75-50 (1), Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio, 1975.

# IN-FLIGHT NOISE

## MEASUREMENTS

All noise measurements were made on-board an A-10A aircraft during typical speed, altitude, and flight maneuver conditions. These levels describe the standard A-10A environments but may not be representative of those levels encountered if the aircraft has been configured differently (e.g., major equipment or structural changes).

Measurements were made inside the cockpit at the pilot's location with MICROPAK, which is a small in-flight recording system worn by the pilot. The miniature electret condenser microphone was attached to the pilot's helmet on a light-weight boom and positioned at ear level 0.1 meter from the helmet's surface with its diaphragm parallel to the surface pointing away from the helmet.

In the analysis, microphone corrections for random incidence were applied to the overall system's response. The recorded samples were analyzed using a 4- or 8-second integration time to obtain power-averaged levels that effectively smooth out short duration fluctuations and best describes the exposure.

Table 1 lists the measurement location and test conditions as numeric/ alphabetic designators which are used on the data pages. The designator 1/A means measurement location 1 and test condition A.

## RESULTS

The measured data presented in Table 2 define the sound pressure levels (SPL) produced inside the A-10A aircraft at the specified location. This table includes the overall, 1/3 octave band, and octave band levels. From these data, C-weighted and A-weighted sound levels, maximum permissible time for one exposure per day (AFR 161-35) with and without standard Air Force ear protectors, preferred speech interference level, and perceived noise level are calculated and presented in Table 3. These measures are widely used to assess the effects of noise on personnel and their performance.

## TABLE 1

## MEASUREMENT LOCATION AND TEST CONDITIONS

**A-10A, EDWARDS AFB, 14 APRIL 1976**

| *LOCATION* | *POSITION* | *HEIGHT ABOVE DECK* |
|---|---|---|
| 1 | Cockpit | Seated Head Level |

| *CONDITION* | *DESCRIPTION* |
|---|---|
| A | Engine Start — Canopy Open |
| B | Runup — Max. Power |
| C | Takeoff — Max Power |
| D | Climb — 2500′ ↗ 5000′ MSL — Intermediate Power 190 KIAS |
| E | Climb — 5000′ ↗ 7000′MSL — Intermediate Power 200 KIAS — ECS System On, Flow At Minimum |
| F | Climb — 7000′↗10000′ MSL — Intermediate Power 200 KIAS — ECS System On, Flow At Medium |
| G | Climb — 10000′ ↗ 15000′ MSL — Intermediate Power — ECS System On, Flow At Medium |
| H | Cruise — 15000′ MSL — Intermediate Power — ECS System On, Flow At Minimum |
| I | Cruise — 15000′ MSL, 255 KIAS |
| J | Descent — 15000′ 5000′ MSL |
| K | Range Sweep — 5000′ MSL, 255 KIAS |
| L | 1st Gun Firing — GAU-8/A |
| M | 2nd Gun Firing — GAU-8/A |
| N | 3rd Gun Firing — GAU-8/A |
| P | Cruise — 11000′ MSL, 80% RPM — Speed Brakes Extended |
| S | Traffic Pattern — 160 KIAS |

TABLE: 2 MEASURED SOUND PRESSURE LEVEL (DB)
1/3 OCTAVE BAND

IDENTIFICATION:
OMEGA 3.2
TEST 75-049-001
RUN 01
08 SEP 76
PAGE F1

NOISE SOURCE/SUBJECT:
A-10A AIRCRAFT
INFLIGHT NOISE LEVELS

OPERATION:

LOCATION/CONDITION

| FREQ (HZ) | 1/A | 1/B | 1/C | 1/D | 1/E | 1/F | 1/G | 1/H | 1/I |
|---|---|---|---|---|---|---|---|---|---|
| 50 | 78 | 87 | 76 | 77 | 78 | 81 | 83 | 75 | 73 |
| 63 | 77 | 90 | 85 | 84 | 83 | 87 | 87 | 82 | 81 |
| 80 | 82 | 83 | 81 | 79 | 79 | 80 | 82 | 74 | 75 |
| 100 | 87 | 88 | 86 | 86 | 85 | 87 | 87 | 87 | 90 |
| 125 | 88 | 90 | 86 | 84 | 84 | 87 | 86 | 85 | 87 |
| 160 | 83 | 93 | 92 | 90 | 88 | 90 | 90 | 88 | 90 |
| 200 | 86 | 87 | 96 | 89 | 88 | 91 | 90 | 87 | 89 |
| 250 | 82 | 88 | 91 | 90 | 90 | 91 | 91 | 91 | 92 |
| 315 | 92 | 89 | 92 | 92 | 90 | 94 | 93 | 91 | 93 |
| 400 | 90 | 87 | 88 | 88 | 87 | 90 | 89 | 90 | 93 |
| 500 | 82 | 83 | 88 | 89 | 88 | 90 | 90 | 89 | 92 |
| 630 | 84 | 81 | 86 | 86 | 85 | 90 | 89 | 86 | 91 |
| 800 | 87 | 83 | 87 | 87 | 86 | 92 | 91 | 86 | 89 |
| 1000 | 87 | 86 | 85 | 86 | 85 | 92 | 91 | 85 | 88 |
| 1250 | 86 | 84 | 84 | 84 | 83 | 91 | 90 | 83 | 84 |
| 1600 | 86 | 83 | 83 | 84 | 84 | 92 | 90 | 83 | 85 |
| 2000 | 88 | 83 | 82 | 83 | 82 | 91 | 90 | 81 | 84 |
| 2500 | 88 | 82 | 82 | 83 | 83 | 92 | 92 | 82 | 82 |
| 3150 | 88 | 82 | 81 | 82 | 82 | 92 | 93 | 82 | 80 |
| 4000 | 87 | 81 | 80 | 81 | 81 | 94 | 93 | 82 | 82 |
| 5000 | 86 | 78 | 80 | 80 | 80 | 91 | 90 | 81 | 82 |
| 6300 | 88 | 79 | 84 | 83 | 83 | 92 | 92 | 83 | 85 |
| 8000 | 86 | 80 | 80 | 80 | 80 | 93 | 92 | 82 | 83 |
| 10000 | 83 | 77 | 77 | 78 | 78 | 92 | 91 | 82 | 82 |
| OVERALL | 100 | 100 | 101 | 100 | 99 | 105 | 104 | 99 | 102 |

LEVEL CORRECTED TO REMOVE BACKGROUND/ELECTRONIC NOISE.

TABLE: 2 MEASURED SOUND PRESSURE LEVEL (DB)
1/3 OCTAVE BAND

IDENTIFICATION:
OMEGA 3.2
TEST 75-049-001
RUN 02
08 SEP 76
PAGE F2

NOISE SOURCE/SUBJECT:
A-10A AIRCRAFT
INFLIGHT NOISE LEVELS

OPERATION:

LOCATION/CONDITION

| FREQ (HZ) | 1/J | 1/K | 1/L | 1/M | 1/N | 1/P | 1/R | 1/S |
|---|---|---|---|---|---|---|---|---|
| 50 | 77 | 84 | 98 | 95 | 96 | 70 | 67 | 74 |
| 63 | 86 | 91 | 105 | 104 | 105 | 81 | 75 | 79 |
| 80 | 82 | 82 | 102 | 97 | 102 | 75 | 80 | 83 |
| 100 | 90 | 95 | 106 | 99 | 102 | 81 | 77 | 81 |
| 125 | 87 | 94 | 107 | 99 | 104 | 82 | 83 | 86 |
| 160 | 93 | 95 | 111 | 103 | 108 | 89 | 82 | 87 |
| 200 | 93 | 95 | 110 | 110 | 114 | 87 | 90 | 91 |
| 250 | 95 | 100 | 110 | 105 | 110 | 87 | 87 | 92 |
| 315 | 95 | 101 | 109 | 105 | 110 | 89 | 89 | 87 |
| 400 | 91 | 97 | 104 | 103 | 108 | 85 | 88 | 89 |
| 500 | 92 | 98 | 104 | 103 | 104 | 85 | 83 | 89 |
| 630 | 90 | 97 | 103 | 103 | 105 | 82 | 83 | 81 |
| 800 | 90 | 96 | 106 | 105 | 109 | 82 | 81 | 78 |
| 1000 | 88 | 96 | 104 | 102 | 107 | 81 | 80 | 78 |
| 1250 | 86 | 97 | 100 | 98 | 100 | 81 | 81 | 79 |
| 1600 | 86 | 96 | 98 | 96 | 97 | 80 | 80 | 79 |
| 2000 | 85 | 93 | 96 | 94 | 96 | 77 | 79 | 79 |
| 2500 | 83 | 90 | 95 | 93 | 95 | 76 | 76 | 77 |
| 3150 | 81 | 88 | 94 | 94 | 96 | 76 | 76 | 76 |
| 4000 | 82 | 89 | 95 | 97 | 98 | 75 | 76 | 76 |
| 5000 | 83 | 89 | 94 | 96 | 97 | 76 | 73 | 71 |
| 6300 | 86 | 90 | 95 | 98 | 101 | 77 | 75 | 70 |
| 8000 | 83 | 90 | 96 | 97 | 100 | 74 | 73 | 70 |
| 10000 | 80 | 91 | 96 | 91 | 94 | 71 | 69 | 68 |
| OVERALL | 103 | 109 | 119 | 116 | 119 | 97 | 96 | 98 |

LEVEL CORRECTED TO REMOVE BACKGROUND/ELECTRONIC NOISE.

TABLE: 2 MEASURED SOUND PRESSURE LEVEL (DB)
OCTAVE BAND

IDENTIFICATION:
OMEGA 3.2
TEST 75-049-001
RUN 01
08 SEP 76
PAGE J1

NOISE SOURCE/SUBJECT:
A-10A AIRCRAFT
INFLIGHT NOISE LEVELS

OPERATION:

| FREQ (HZ) | LOCATION/CONDITION 1/A | 1/B | 1/C | 1/D | 1/E | 1/F | 1/G | 1/H | 1/I |
|---|---|---|---|---|---|---|---|---|---|
| 63 | 84 | 92 | 87 | 85 | 85 | 88 | 89 | 83 | 83 |
| 125 | 91 | 95 | 94 | 92 | 91 | 93 | 93 | 91 | 94 |
| 250 | 93 | 93 | 98 | 95 | 94 | 97 | 96 | 95 | 96 |
| 500 | 91 | 89 | 92 | 92 | 92 | 95 | 94 | 93 | 97 |
| 1000 | 92 | 89 | 90 | 90 | 89 | 96 | 95 | 90 | 92 |
| 2000 | 92 | 88 | 87 | 88 | 88 | 97 | 95 | 87 | 88 |
| 4000 | 92 | 85 | 85 | 86 | 86 | 97 | 97 | 86 | 86 |
| 8000 | 91 | 84 | 86 | 86 | 86 | 97 | 97 | 87 | 88 |
| OVERALL | 100 | 100 | 101 | 100 | 99 | 105 | 104 | 99 | 102 |

TABLE: 2 MEASURED SOUND PRESSURE LEVEL (DB) OCTAVE BAND

IDENTIFICATION:
OMEGA 3.2
TEST 75-049-001
RUN 02
08 SEP 76
PAGE J2

NOISE SOURCE/SUBJECT:
A-10A AIRCRAFT
INFLIGHT NOISE LEVELS

OPERATION:

| FREQ (HZ) | LOCATION/CONDITION 1/J | 1/K | 1/L | 1/M | 1/N | 1/P | 1/R | 1/S |
|---|---|---|---|---|---|---|---|---|
| 63 | 88 | 92 | 107 | 105 | 107 | 82 | 81 | 85 |
| 125 | 95 | 99 | 114 | 106 | 110 | 90 | 86 | 90 |
| 250 | 99 | 104 | 114 | 112 | 116 | 93 | 93 | 95 |
| 500 | 96 | 102 | 108 | 108 | 111 | 89 | 90 | 92 |
| 1000 | 93 | 101 | 108 | 107 | 111 | 86 | 85 | 83 |
| 2000 | 90 | 98 | 101 | 99 | 101 | 83 | 83 | 83 |
| 4000 | 87 | 94 | 99 | 100 | 102 | 80 | 80 | 79 |
| 8000 | 88 | 95 | 100 | 101 | 104 | 79 | 77 | 74 |
| OVERALL | 103 | 109 | 119 | 116 | 119 | 97 | 96 | 98 |

TABLE: 3 MEASURES OF HUMAN NOISE EXPOSURE

IDENTIFICATION:
OMEGA 3.2
TEST 75-049-001
RUN 01
08 SEP 76
PAGE H1

NOISE SOURCE/SUBJECT:
A-10A AIRCRAFT
INFLIGHT NOISE LEVELS

OPERATION:

| | LOCATION/CONDITION | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1/A | 1/B | 1/C | 1/D | 1/E | 1/F | 1/G | 1/H | 1/I |
| **HAZARD/PROTECTION** | | | | | | | | | |
| C-WEIGHTED OVERALL SOUND LEVEL (OASLC IN DBC) AT EAR | | | | | | | | | |
| A-WEIGHTED OVERALL SOUND LEVEL (OASLA IN DBA) AT EAR | | | | | | | | | |
| MAXIMUM PERMISSIBLE TIME (T IN MINUTES) FOR ONE EXPOSURE PER DAY (AFR 161-35, JULY 73) | | | | | | | | | |
| NO PROTECTION | | | | | | | | | |
| OASLC | 100 | 100 | 101 | 100 | 99 | 104 | 103 | 99 | 102 |
| OASLA | 99 | 95 | 96 | 96 | 95 | 104 | 103 | 96 | 98 |
| T | 36 | 71 | 60 | 60 | 71 | 15 | 18 | 60 | 42 |
| HGU-2A/P HELMET WITH H-154 | | | | | | | | | |
| OASLA* | 86 | 86 | 89 | 87 | 86 | 91 | 90 | 87 | 89 |
| T | 339 | 339 | 202 | 285 | 339 | 143 | 170 | 285 | 202 |
| HGU-2A/P HELMET WITH H-154(A) | | | | | | | | | |
| OASLA* | 82 | 82 | 85 | 83 | 82 | 85 | 85 | 83 | 85 |
| T | 679 | 679 | 404 | 571 | 679 | 404 | 404 | 571 | 404 |
| HGU-2A/P HELMET WITH CUSTOM LINER | | | | | | | | | |
| OASLA* | 91 | 90 | 92 | 91 | 90 | 95 | 94 | 91 | 94 |
| T | 143 | 170 | 120 | 143 | 170 | 71 | 85 | 143 | 85 |
| **COMMUNICATION** | | | | | | | | | |
| PREFERRED SPEECH INTERFERENCE LEVEL (PSIL IN DB) | | | | | | | | | |
| PSIL | 92 | 89 | 90 | 90 | 90 | 96 | 95 | 90 | 92 |
| **ANNOYANCE** | | | | | | | | | |
| PERCEIVED NOISE LEVEL, TONE CORRECTED (PNLT IN PNDB) | | | | | | | | | |
| TONE CORRECTION (C IN DB) | | | | | | | | | |
| PNLT | 114 | 110 | 111 | 110 | 110 | 118 | 118 | 111 | 112 |
| C | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

* BASED ON CALCULATED SPL SPECTRUM UNDER PROTECTIVE DEVICE.

TABLE: 3 MEASURES OF HUMAN NOISE EXPOSURE

IDENTIFICATION:
OMEGA 3.2
TEST 75-049-001
RUN 02
08 SEP 76
PAGE H2

NOISE SOURCE/SUBJECT:
A-10A AIRCRAFT
INFLIGHT NOISE LEVELS

OPERATION:

| | LOCATION/CONDITION | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1/J | 1/K | 1/L | 1/M | 1/N | 1/P | 1/R | 1/S |
| **HAZARD/PROTECTION** | | | | | | | | |
| C-WEIGHTED OVERALL SOUND LEVEL (OASLC IN DBC) AT EAR | | | | | | | | |
| A-WEIGHTED OVERALL SOUND LEVEL (OASLA IN DBA) AT EAR | | | | | | | | |
| MAXIMUM PERMISSIBLE TIME (T IN MINUTES) FOR ONE EXPOSURE PER DAY (AFR 161-35, JULY 73) | | | | | | | | |
| NO PROTECTION | | | | | | | | |
| OASLC | 103 | 108 | 119 | 116 | 119 | 97 | 96 | 98 |
| OASLA | 99 | 106 | 112 | 111 | 114 | 92 | 92 | 92 |
| T | 36 | 11 | 3.8 | 4.5 | 2.7 | 120 | 120 | 120 |
| HGU-2A/P HELMET WITH H-154 | | | | | | | | |
| OASLA* | 91 | 96 | 106 | 103 | 107 | 85 | 85 | 87 |
| T | 143 | 60 | 11 | 18 | 9 | 404 | 404 | 285 |
| HGU-2A/P HELMET WITH H-154(A) | | | | | | | | |
| OASLA* | 87 | 92 | 102 | 99 | 103 | 81 | 81 | 83 |
| T | 285 | 120 | 21 | 36 | 18 | 807 | 807 | 571 |
| HGU-2A/P HELMET WITH CUSTOM LINER | | | | | | | | |
| OASLA* | 95 | 101 | 109 | 107 | 111 | 88 | 88 | 90 |
| T | 71 | 25 | 6 | 9 | 4.5 | 240 | 240 | 170 |
| **COMMUNICATION** | | | | | | | | |
| PREFERRED SPEECH INTERFERENCE LEVEL (PSIL IN DB) | | | | | | | | |
| PSIL | 93 | 100 | 106 | 105 | 108 | 86 | 86 | 86 |
| **ANNOYANCE** | | | | | | | | |
| PERCEIVED NOISE LEVEL, TONE CORRECTED (PNLT IN PNDB) | | | | | | | | |
| TONE CORRECTION (C IN DB) | | | | | | | | |
| PNLT | 113 | 120 | 126 | 125 | 128 | 106 | 106 | 106 |
| C | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

* BASED ON CALCULATED SPL SPECTRUM UNDER PROTECTIVE DEVICE.



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